PB-247 345

NOXONTOWN POND, NEW CASTLE COUNTY, DELAWARE. EPA REGION III

Pacific Northwest Environmental Research Laboratory

Prepared for:

National Environmental Research Center

June 1975

DISTRIBUTED BY:

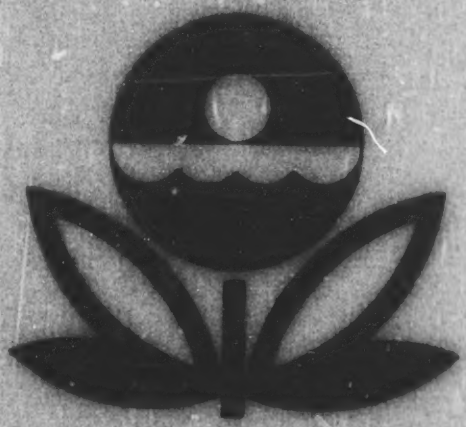
NTIS

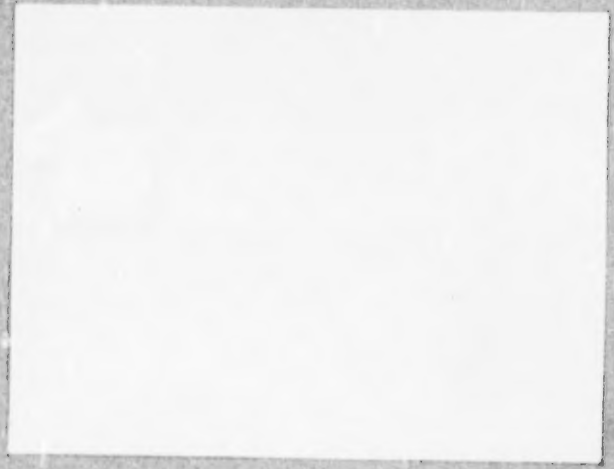
National Technical Information Service
U. S. DEPARTMENT OF COMMERCE

PB 247 345

U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL EUTROPHICATION SURVEY

WORKING PAPER SERIES





PACIFIC NORTHWEST ENVIRONMENTAL RESEARCH LABORATORY

An Associate Laboratory of the

NATIONAL ENVIRONMENTAL RESEARCH CENTER - CORVALLIS, OREGON

and

NATIONAL ENVIRONMENTAL RESEARCH CENTER - LAS VEGAS, NEVADA

Reproduced by
NATIONAL TECHNICAL
INFORMATION SERVICE
US Department of Commerce
Springfield, VA. 22151

TECHNICAL REPORT DATA
(Please read Instructions on the reverse before completing)

1. REPORT NO.	2.	3. RECIPIENT'S ACCESSION NO.

4. TITLE AND SUBTITLE
Report on Noxontown Pond, New Castle County, Delaware

5. REPORT DATE
Prepared June 1975

6. PERFORMING ORGANIZATION CODE

7. AUTHOR(S)
Anonymous (National Eutrophication Survey Staff)

8. PERFORMING ORGANIZATION REPORT NO.
Working Paper No. 239

9. PERFORMING ORGANIZATION NAME AND ADDRESS
National Eutrophication Survey
U.S. Environmental Protection Agency
P.O. Box 15027
Las Vegas, NV 89114

10. PROGRAM ELEMENT NO.

11. CONTRACT/GRANT NO.

12. SPONSORING AGENCY NAME AND ADDRESS
Office of Research and Development
U.S. Environmental Protection Agency
401 M Street, S. W.
Washington, DC 20460

13. TYPE OF REPORT AND PERIOD COVERED
Final - 1973

14. SPONSORING AGENCY CODE

15. SUPPLEMENTARY NOTES
Prepared in cooperation with the U.S. Environmental Protection Agency, Corvallis Environmental Research Laboratory, Eutrophication Survey Branch, Corvallis, OR 97330

16. ABSTRACT
Annual total phosphorus and total nitrogen loadings to the lake were estimated and subdivided according to either point or non-point source origin. An assessment of the lake's trophic condition and limiting nutrient is also provided. All data collected by the U.S.E.P.A. National Eutrophication Survey during the one year study of the lake and its tributaries are included in the report.

17. KEY WORDS AND DOCUMENT ANALYSIS

DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
eutrophication lakes nutrients phosphorus nitrogen loading		05B 05C

PRICES SUBJECT TO CHANGE

18. DISTRIBUTION STATEMENT	19. SECURITY CLASS *(This Report)*	21. NO. OF PAGES
Release unlimited		39
1a	20. SECURITY CLASS *(This page)*	22. PRICE
		4.00 - 2.25

EPA Form 2220-1 (9-73)

345055

REPORT ON

NOXONTOWN POND

NEW CASTLE COUNTY

DELAWARE

EPA REGION III

WORKING PAPER No. 239

WITH THE COOPERATION OF THE

DELAWARE DEPARTMENT OF NATURAL RESOURCES

AND ENVIRONMENTAL CONTROL AND THE

DELAWARE NATIONAL GUARD

JUNE 1975

REPORT ON NOXONTOWN POND

NEW CASTLE COUNTY, DELAWARE, EPA REGION III

by

National Eutrophication Survey

Water and Land Monitoring Branch
Monitoring Applications Laboratory
National Environmental Research Center
Las Vegas, Nevada

and

Eutrophication Survey Branch
Pacific Northwest Environmental Research Laboratory
National Environmental Research Center
Corvallis, Oregon

Working Paper No. 239

OFFICE OF RESEARCH AND DEVELOPMENT
U.S. ENVIRONMENTAL PROTECTION AGENCY

June 1975

ib

CONTENTS

	Page
Foreword	ii
List of Delaware Study Lakes	iv
Lake and Drainage Area Map	v
Sections	
I. Conclusions	1
II. Lake and Drainage Basin Characteristics	3
III. Lake Water Quality Summary	5
IV. Nutrient Loadings	9
V. Literature Reviewed	14
VI. Appendices	15

FOREWORD

The National Eutrophication Survey was initiated in 1972 in response to an Administration commitment to investigate the nationwide threat of accelerated eutrophication to freshwater lakes and reservoirs.

OBJECTIVES

The Survey was designed to develop, in conjunction with state environmental agencies, information on nutrient sources, concentrations, and impact on selected freshwater lakes as a basis for formulating comprehensive and coordinated national, regional, and state management practices relating to point source discharge reduction and nonpoint source pollution abatement in lake watersheds.

ANALYTIC APPROACH

The mathematical and statistical procedures selected for the Survey's eutrophication analysis are based on related concepts that:

a. A generalized representation or model relating sources, concentrations, and impacts can be constructed.

b. By applying measurements of relevant parameters associated with lake degradation, the generalized model can be transformed into an operational representation of a lake, its drainage basin, and related nutrients.

c. With such a transformation, an assessment of the potential for eutrophication control can be made.

LAKE ANALYSIS

In this report, the first stage of evaluation of lake and watershed data collected from the study lake and its drainage basin is documented. The report is formatted to provide state environmental agencies with specific information for basin

planning [§303(e)], water quality criteria/standards review [§303(c)], clean lakes [§314(a,b)], and water quality monitoring [§106 and §305(b)] activities mandated by the Federal Water Pollution Control Act Amendments of 1972.

Beyond the single lake analysis, broader based correlations between nutrient concentrations (and loading) and trophic condition are being made to advance the rationale and data base for refinement of nutrient water quality criteria for the Nation's freshwater lakes. Likewise, multivariate evaluations for the relationships between land use, nutrient export, and trophic condition, by lake class or use, are being developed to assist in the formulation of planning guidelines and policies by EPA and to augment plans implementation by the states.

ACKNOWLEDGMENTS

The staff of the National Eutrophication Survey (Office of Research and Development, U.S. Environmental Protection Agency) expresses sincere appreciation to the Delaware Department of Natural Resources and Environmental Control for professional involvement and to the Delaware National Guard for conducting the tributary sampling phase of the Survey.

Mr. N. C. Vasuki, Director, Division of Water Pollution Control, Department of Natural Resources and Environmental Control, provided invaluable lake documentation and counsel during the course of the Survey.

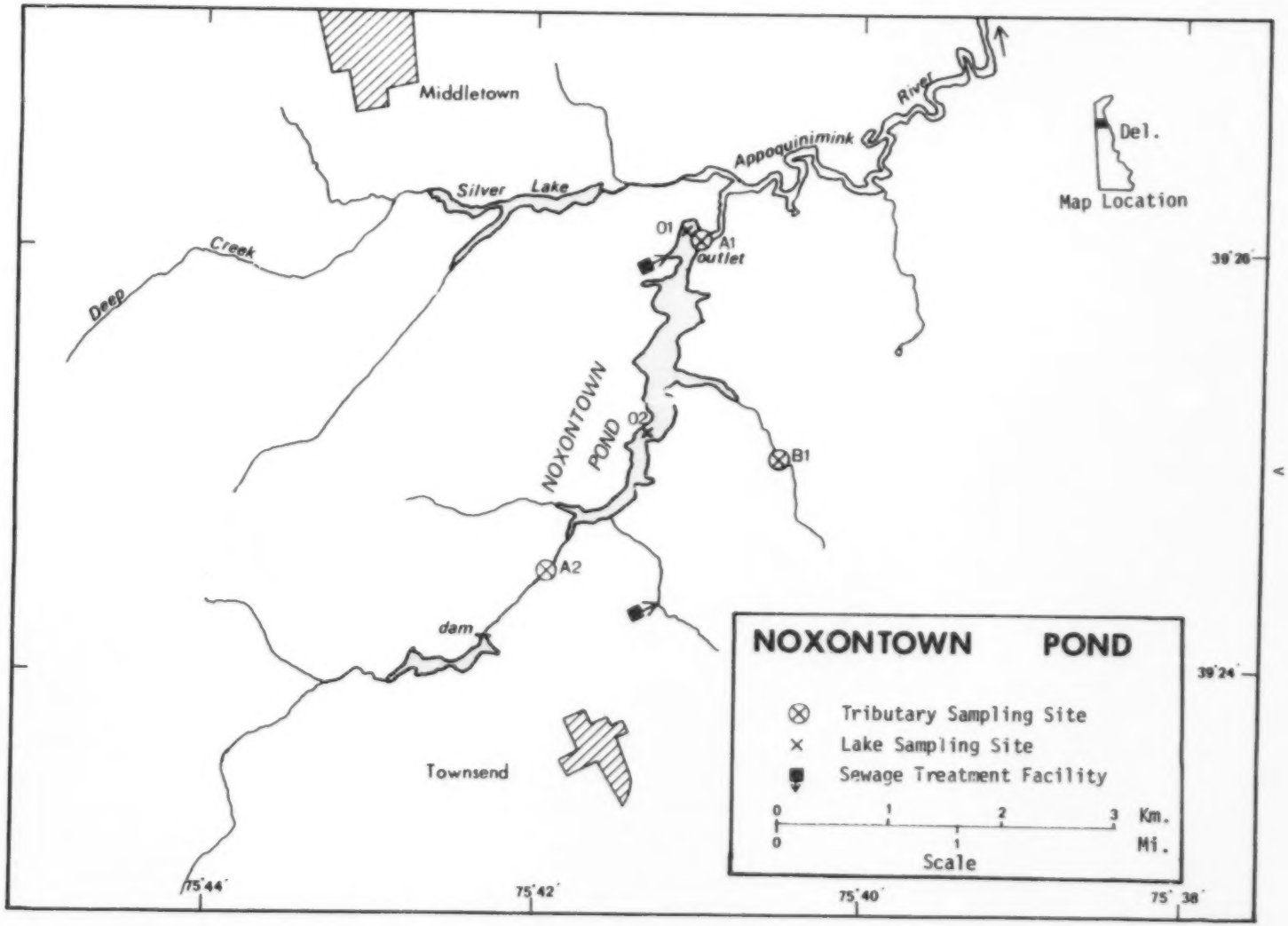
Major General Clarence E. Atkinson, the Adjutant General of Delaware, and Project Officer Colonel Donald S. Robinson, who directed the volunteer efforts of the Delaware National Guardsmen, are also gratefully acknowledged for their assistance to the Survey.

NATIONAL EUTROPHICATION SURVEY

STUDY LAKES

STATE OF DELAWARE

LAKE NAME	COUNTY
Killen Pond	Kent
Moores Lake	Kent
Noxontown Pond	New Castle
Silver Lake	New Castle
Williams Pond	Sussex
Trussum Pond	Sussex


Middletown
Silver Lake
Deep Creek
Appoquinimink River
Del.
Map Location
O1
A1
outlet
NOXONTOWN POND
O2
B1
A2
dam
Townsend
NOXONTOWN POND
Tributary Sampling Site
Lake Sampling Site
Sewage Treatment Facility
0 1 2 3 Km.
0 1 Mi.
Scale
39°26'
39°24'
75°44'
75°42'
75°40'
75°38'

NOXONTOWN POND

STORET NO. 1007

I. CONCLUSIONS

A. Trophic Condition:

Noxontown Pond is considered eutrophic based upon field observations and analysis of Survey data. Emergent higher aquatic plants were observed during the field investigation. Water clarity was low, being "greenish to brown" and turbid. Chlorophyll a levels ranged from a low of 2.9 micrograms/liter in the spring to a high of 76.1 micrograms/liter in the summer. The lake is characterized by high nutrient concentrations (0.160 mg/l median total phosphorus, 0.530 mg/l median inorganic nitrogen) and high potential for primary productivity as measured by algal assay control yield.

B. Rate-Limiting Nutrient:

Algal assay results show that Noxontown Pond was phosphorus limited at the time the assay sample was collected (04/10/73). The lake data indicate phosphorus limitation at the other sampling times as well.

C. Nutrient Controllability:

1. Point Sources - The mean annual phosphorus load from point sources was 19.4% of the total load reaching Noxontown Pond. The Townsend sewage treatment plant contributed 15.1% and the St. Andrews School in Middletown contributed 4.3%. The present loading rate of 3.84 $g/m^2/yr$ is above four times that proposed by Vollenweider (in press) as "dangerous" or eutrophic and about nine times the oligotrophic rate. Total phosphorus reduction at the two wastewater treatment plants cited above would not appreciably change the loading rate.

2. Nonpoint Sources - The mean annual phosphorus load from nonpoint sources was about 81% of the total reaching the lake. The measured tributaries accounted for 49% of the total phosphorus load and the ungaged drainage areas were estimated to have contributed about 31%. Surrounding land uses and additional point sources contributing to Noxontown Pond must be analyzed before definitive recommendations on controllability can be made.

II. LAKE AND DRAINAGE BASIN CHARACTERISTICS

Lake and drainage basin characteristics are itemized below. The Noxontown Pond surface area was provided by the State of Delaware; mean depth was estimated based on survey data; tributary flow data were provided by the Delaware District Office of the U.S. Geological Survey (USGS)(outlet drainage area includes the lake surface area). Mean hydraulic retention time was obtained by dividing the lake volume by the mean flow of the outlet. Precipitation values are estimated by methods as outlined in National Eutrophication Survey (NES) Working Paper No. 175. A table of metric/English conversions is included as Appendix A.

A. Lake Morphometry:

1. Surface area: 0.64 km^2.
2. Mean depth: 1.1 meters.
3. Maximum depth: 1.8 meters.
4. Volume: 0.704×10^6 m^3.
5. Mean hydraulic retention time: 20 days.

B. Tributary and Outlet (see Appendix C for flow data):

1. Tributaries -

Name	Drainage area(km^2)	Mean flow (m^3/sec)
A(2) Unnamed Inlet	11.2	0.19
B(1) Unnamed Stream	3.5	0.06
Minor tributaries & immediate drainage -	9.6	0.16
Totals	24.3	0.41
2. Outlet - A(1) Unnamed Outlet	24.4	0.42

C. Precipitation:

1. Year of sampling: 132.6 centimeters.

2. Mean annual: 104.5 centimeters.

III. LAKE WATER QUALITY SUMMARY

Noxontown Pond was sampled three times during the open-water season of 1973 by means of a pontoon-equipped Huey helicopter. Each time, samples for physical and chemical parameters were collected from two stations on the lake and from one or more depths at each station (see map, page v). During each visit, depth-integrated samples were collected from each station for chlorophyll a analysis and phytoplankton identification and enumeration. During the first visit, 18.9-liter depth-integrated samples were composited for algal assays. Maximum depths sampled were 1.5 meters at Station 1, and 1.2 meters at Station 2. For a more detailed explanation of NES methods, see NES Working Paper No. 175.

The results obtained are presented in full in Appendix D and are summarized in III A for waters at the surface and at the maximum depth for each site. Results of the phytoplankton counts and chlorophyll a determinations are included in III B. Results of the limiting nutrient study are presented in III C.

A. PHYSICAL AND CHEMICAL CHARACTERISTICS

PARAMETER	(4/10/73) S*** = 2 N*	RANGE	MEDIAN	MAX DEPTH RANGE (METERS)	(7/20/73) S*** = 2 N*	RANGE	MEDIAN	MAX DEPTH RANGE (METERS)	(9/29/73) S*** = 2 N*	RANGE	MEDIAN	MAX DEPTH RANGE (METERS)
TEMPERATURE (DEG CENT)												
0.-1.5 M DEPTH	4	12.0- 13.2	12.6	0.0- 1.2	1	27.3- 27.3	27.3	0.0- 0.0	4	21.2- 21.7	21.5	0.0- 1.5
MAX DEPTH**	2	12.0- 13.0	12.5	0.9- 1.2	1	27.3- 27.3	27.3	0.0- 0.0	2	21.2- 21.4	21.3	1.2- 1.5
DISSOLVED OXYGEN (MG/L)												
0.-1.5 M DEPTH	2	8.8- 10.2	9.5	0.9- 1.2	3	9.0- 10.5	9.6	0.0- 1.2	2	4.6- 6.0	5.3	0.0- 0.0
MAX DEPTH**	2	8.8- 10.2	9.5	0.9- 1.2	2	9.0- 10.5	9.8	0.0- 1.2	0	***** *****	*****	***** *****
CONDUCTIVITY (UMHOS)												
0.-1.5 M DEPTH	4	115.- 120.	118.	0.0- 1.2	3	142.- 158.	143.	0.0- 1.2	4	154.- 161.	158.	0.0- 1.5
MAX DEPTH**	2	115.- 120.	118.	0.9- 1.2	2	143.- 158.	151.	0.0- 1.2	2	161.- 161.	161.	1.2- 1.5
PH (STANDARD UNITS)												
0.-1.5 M DEPTH	4	7.0- 7.1	7.1	0.0- 1.2	3	7.4- 8.5	8.1	0.0- 1.2	2	7.4- 7.6	7.5	0.0- 0.0
MAX DEPTH**	2	7.1- 7.1	7.1	0.9- 1.2	2	7.4- 8.1	7.7	0.0- 1.2	0	***** *****	*****	***** *****
TOTAL ALKALINITY (MG/L)												
0.-1.5 M DEPTH	4	15.- 22.	21.	0.0- 1.2	3	32.- 45.	36.	0.0- 1.2	2	51.- 56.	54.	0.0- 0.0
MAX DEPTH**	2	15.- 22.	19.	0.9- 1.2	2	32.- 45.	39.	0.0- 1.2	0	***** *****	*****	***** *****
TOTAL P (MG/L)												
0.-1.5 M DEPTH	4	0.160-0.266	0.222	0.0- 1.2	3	0.077-0.132	0.093	0.0- 1.2	2	0.120-0.181	0.150	0.0- 0.0
MAX DEPTH**	2	0.179-0.265	0.222	0.9- 1.2	2	0.093-0.132	0.112	0.0- 1.2	0	***** *****	*****	***** *****
DISSOLVED ORTHO P (MG/L)												
0.-1.5 M DEPTH	4	0.021-0.027	0.021	0.0- 1.2	3	0.009-0.013	0.010	0.0- 1.2	2	0.015-0.016	0.015	0.0- 0.0
MAX DEPTH**	2	0.021-0.022	0.021	0.9- 1.2	2	0.010-0.013	0.011	0.0- 1.2	0	***** *****	*****	***** *****
NO2+NO3 (MG/L)												
0.-1.5 M DEPTH	4	0.900-1.900	1.500	0.0- 1.2	3	0.380-0.430	0.380	0.0- 1.2	2	0.200-0.240	0.220	0.0- 0.0
MAX DEPTH**	2	0.900-1.900	1.400	0.9- 1.2	2	0.380-0.430	0.405	0.0- 1.2	0	***** *****	*****	***** *****
AMMONIA (MG/L)												
0.-1.5 M DEPTH	4	0.090-0.300	0.185	0.0- 1.2	3	0.050-0.060	0.050	0.0- 1.2	2	0.160-0.330	0.245	0.0- 0.0
MAX DEPTH**	2	0.090-0.300	0.195	0.9- 1.2	2	0.050-0.060	0.055	0.0- 1.2	0	***** *****	*****	***** *****
KJELDAHL N (MG/L)												
0.-1.5 M DEPTH	4	0.800-1.000	0.900	0.0- 1.2	3	0.900-1.000	1.000	0.0- 1.2	2	2.000-2.100	2.050	0.0- 0.0
MAX DEPTH**	2	0.800-0.900	0.850	0.9- 1.2	2	1.000-1.000	1.000	0.0- 1.2	0	***** *****	*****	***** *****
SECCHI DISC (METERS)												
	2	0.2- 0.4	0.3		2	0.8- 0.8	0.8		2	0.5- 0.5	0.5	

* N = NO. OF SAMPLES
** MAXIMUM DEPTH SAMPLED AT EACH SITE
*** S = NO. OF SITES SAMPLED ON THIS DATE

B. Biological Characteristics:

1. Phytoplankton -

Sampling Date	Dominant Genera		Algal Units per ml
04/10/73	1.	Melosira	15,419
	2.	Synedra	8,037
	3.	Flagellates	2,523
	4.	Asterionella	2,056
	5.	Cryptomonas	1,122
		Other genera	1,496
		Total	30,653
07/20/73	1.	Melosira	2,529
	2.	Flagellates	2,265
	3.	Cryptomonas	1,434
	4.	Scenedesmus	792
	5.	Sphaerocystis	755
		Other genera	3,434
		Total	11,209
09/29/73	1.	Melosira	3,468
	2.	Synedra	2,262
	3.	Scenedesmus	2,161
	4.	Flagellates	1,307
	5.	Blue-green filament	603
		Other genera	3,872
		Total	13,673

2. Chlorophyll a -

Sampling Date	Station Number	Chlorophyll a (micrograms/liter)
04/10/73	1	32.0
	2	2.9
07/20/73	1	35.2
	2	76.1
09/29/73	1	21.2
	2	58.2

C. Limiting Nutrient Study:

1. Autoclaved, filtered, and nutrient spiked -

Spike(mg/l)	Ortho P Conc.(mg/l)	Inorganic N Conc.(mg/l)	Maximum yield (mg/l-dry wt.)
Control	0.036	1.404	11.6
0.05 P	0.086	1.404	32.9
0.05 P + 1.0 N	0.086	2.404	38.3
1.00 N	0.036	2.404	12.7

2. Discussion -

The control yield of the assay alga, Selenastrum capricornutum, indicates that the potential primary productivity was high at the time the assay samples were collected. The increase in yield with the increase of orthophosphorus indicates that Noxontown Pond was limited by phosphorus at that time. Spikes with nitrogen and phosphorus simultaneously resulted in maximum yield. The nitrogen spike alone did not produce any significant increase in the yield. The lake mean total nitrogen to orthophosphorus ratios for the spring, summer, and fall samplings were 71:1, 41:1, and 29:1, respectively, further indicating phosphorus limitation.

IV. NUTRIENT LOADINGS
(See Appendix E for data)

For the determination of nutrient loadings, the Delaware National Guard collected monthly near-surface grab samples from each of the tributary sites indicated on the map (page v), except for the high runoff month of March when two samples were collected. Sampling was begun in April 1973 and was completed in March 1974.

Through an interagency agreement, stream flow estimates for the year of sampling and a "normalized" or average year were provided by the Delaware District Office of the USGS for the tributary sites nearest the lake.

In this report, nutrient loads for sampled tributaries were determined by using a modification of the USGS computer program for calculating stream loadings. Nutrient loads indicated for tributaries are those measured minus known point source loads, if any.

Nutrient loadings for unsampled "minor tributaries and immediate drainage" ("ZZ" of USGS) were estimated by using the mean annual concentrations in Unnamed Inlet and Unnamed Stream at Stations A(2) and B(1), and mean annual ZZ flow.

The operators of the St. Andrews School, Middletown, and Townsend wastewater treatment plants provided monthly effluent samples and corresponding flow data.

A. Waste Sources:

1. Known municipal -

Name	Population Served*	Treatment	Mean Flow ($m^3/d \times 10^6$)	Receiving Water
St. Andrews School, Middletown	250	Activated Sludge	0.057	Appoquinimink River
Townsend STP	505	Activated Sludge	0.246	Unnamed Inlet

2. Known industrial - None

*Provided by the State of Delaware.

B. Annual Total Phosphorus Loading - Average Year:

1. Inputs -

Source	kg P/yr	% of total
a. Tributaries (nonpoint load) -		
A(2) Unnamed Inlet	860	35.0
B(1) Unnamed Stream	350	14.2
b. Minor tributaries & immediate drainage (nonpoint load) -	755	30.8
c. Known municipal STP's -		
St. Andrews School, Middletown	105	4.3
Townsend STP	370	15.1
d. Septic tanks* -	5	0.2
e. Known industrial - None		
f. Direct precipitation** -	10	0.4
Total	2,455	100.0

2. Outputs - A(1) Unnamed 1,355

3. Net annual P accumulation - 1,100 kg.

*Estimate based on 48 lakeside residences.
**Estimated (See NES Working Paper No. 175).

C. Annual Total Nitrogen Loading - Average Year:

1. Inputs -

Source	kg N/yr	% of total
a. Tributaries (nonpoint load) -		
A(2) Unnamed Inlet	18,800	45.8
B(1) Unnamed Stream	4,320	10.5
b. Minor tributaries & immediate drainage (nonpoint load) -	15,585	38.0
c. Known municipal STP's -		
St. Andrews School, Middletown	395	1.0
Townsend STP	1,205	2.9
d. Septic tanks * -	20	0.1
e. Known industrial -	None	
f. Direct precipitation** -	690	1.7
Total	41,015	100.0

2. Outputs - A(1) Unnamed 22,735

3. Net annual N accumulation - 18,280 kg.

*Estimate based on 48 lakeside residences.
**Estimated (See NES Working Paper No. 175).

D. Mean Annual Nonpoint Nutrient Export by Subdrainage Area:

Tributary	kg P/km^2/yr	kg N/km^2/yr
A(1) Unnamed Inlet	77	1,679
B(1) Unnamed Stream	100	1,234

E. Yearly Loading Rates:

In the following table, the existing phosphorus loading rates are compared to those proposed by Vollenweider (in press). Essentially, his "dangerous" rate is the rate at which the receiving waters would become eutrophic or remain eutrophic; his "permissible" rate is that which would result in the receiving water remaining oligotrophic or becoming oligotrophic if morphometry permitted. A mesotrophic rate would be considered one between "dangerous" and "permissible."

	Total Yearly Phosphorus Loading Rate (grams/m^2/year)
Estimated loading rate for Noxontown Pond	3.84
Vollenweider's "dangerous" or eutrophic rate	0.86
Vollenweider's "permissible" or oligotrophic rate	0.43

V. LITERATURE REVIEWED

U.S. Environmental Protection Agency. 1975. "National Eutrophication Survey Methods for 1973-1976." Working Paper No. 175. NERC, Las Vegas, Nevada, and PNERL, Corvallis, Oregon.

Vollenweider, Richard A. (in press). "Input-Output Models." Schweiz. Z. Hydrol.

CONVERSION FACTORS

Hectares x 2.471 = acres

Meters x 3.281 = feet

Cubic meters x 8.107×10^{-4} = acre feet

Square kilometers x 0.3861 = square miles

Cubic meters/sec x 35.315 = cubic feet/sec

Centimeters x 0.3937 = inches

Kilograms x 2.205 = pounds

Kilograms/square kilometer x 5.711 = lbs/square mile

APPENDIX B

PARAMETRIC RANKINGS OF LAKES

SAMPLED BY NES IN 1973

STATE OF DELAWARE

PERCENT OF LAKES WITH HIGHER VALUES (NUMBER OF LAKES WITH HIGHER VALUES)

LAKE CODE	LAKE NAME	MEDIAN TOTAL P	MEDIAN INORG N	500- MEAN SEC	MEAN CHLORA	15- MIN DO	MEDIAN DISS ORTHO P
1002	KILLEN POND	40 (2)	60 (3)	0 (0)	0 (0)	20 (1)	40 (2)
1005	MOORES LAKE	0 (0)	20 (1)	40 (2)	20 (1)	100 (5)	20 (1)
1007	NOXONTOWN POND	60 (3)	100 (5)	20 (1)	40 (2)	40 (2)	60 (3)
1008	SILVER LAKE	20 (1)	0 (0)	60 (3)	80 (4)	0 (0)	0 (0)
1009	WILLIAMS POND	80 (4)	40 (2)	100 (5)	60 (3)	60 (3)	100 (5)
1010	TRUSSUM POND	100 (5)	80 (4)	80 (4)	100 (5)	80 (4)	80 (4)

LAKE DATA TO BE USED IN RANKINGS

LAKE CODE	LAKE NAME	MEDIAN TOTAL P	MEDIAN INORG N	500-MEAN SEC	MEAN CHLORA	15-MIN DO	MEDIAN DISS ORTHO P
1002	KILLEN POND	0.170	1.610	479.333	116.200	12.000	0.042
1005	MOORES LAKE	0.245	2.400	472.667	81.267	4.700	0.071
1007	NOXONTOWN POND	0.160	0.530	478.833	37.600	10.400	0.016
1008	SILVER LAKE	0.227	4.750	465.667	26.700	13.000	0.096
1009	WILLIAMS POND	0.042	2.010	449.333	30.100	8.800	0.010
1010	TRUSSUM POND	0.038	1.280	464.000	5.100	5.800	0.011

APPENDIX C

TRIBUTARY FLOW DATA

TRIBUTARY FLOW INFORMATION FOR DELAWARE 10/20/75

LAKE CODE 1007 NOXONTOWN POND

TOTAL DRAINAGE AREA OF LAKE(SQ MI) 9.41

TRIBUTARY	SUB-DRAINAGE AREA(SQ MI)	NORMALIZED FLOWS(CFS) JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN
1007A1	9.41	17.70	18.70	20.40	16.00	12.80	13.30	11.60	14.50	12.70	10.10	13.40	15.30	14.68
1007A2	4.34	8.20	8.70	9.50	7.40	5.90	6.20	5.40	6.70	5.90	4.70	6.20	7.10	6.81
1007B1	1.36	2.60	2.70	3.00	2.30	1.90	1.90	1.70	2.10	1.90	1.50	2.00	2.20	2.15
1007ZZ	3.71	6.90	7.30	7.90	6.30	5.00	5.20	4.50	5.70	4.90	3.90	5.20	6.00	5.72

SUMMARY

TOTAL DRAINAGE AREA OF LAKE = 9.41
SUM OF SUB-DRAINAGE AREAS = 9.41

TOTAL FLOW IN = 176.50
TOTAL FLOW OUT = 176.50

MEAN MONTHLY FLOWS AND DAILY FLOWS(CFS)

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
1007A1	4	73	32.20	28	32.00				
	5	73	21.90	20	21.00				
	6	73	48.00	25	16.00				
	7	73	24.80	23	15.00				
	8	73	25.30	20	13.00				
	9	73	13.00	16	11.00				
	10	73	20.00	28	11.00				
	11	73	13.00	16	13.00				
	12	73	32.00	4	13.00				
	1	74	21.00	8	15.00				
	2	74	15.00	5	12.00	22	15.00		
	3	74	24.00	11	13.00	22	49.00		
1007A2	4	73	14.90	28	15.00				
	5	73	10.10	20	9.80				
	6	73	22.20	25	7.30				
	7	73	11.50	23	7.00				
	8	73	11.70	20	5.80				
	9	73	5.80	17	5.10				
	10	73	9.20	28	5.00				
	11	73	6.20	16	5.80				
	12	73	15.00	4	5.80				
	1	74	9.90	8	7.20				
	2	74	7.10	5	5.50	22	6.80		
	3	74	11.00	11	6.00	22	23.00		

20.

TRIBUTARY FLOW INFORMATION FOR DELAWARE 10/20/75

LAKE CODE 1007 NOXONTOWN POND

MEAN MONTHLY FLOWS AND DAILY FLOWS(CFS)

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
1007B1	4	73	4.70	28	4.70				
	5	73	3.20	20	3.10				
	6	73	7.00	25	2.30				
	7	73	3.60	23	2.20				
	8	73	3.70	20	1.80				
	9	73	1.80	17	1.60				
	10	73	2.90	28	1.60				
	11	73	1.90	16	1.80				
	12	73	4.70	4	1.80				
	1	74	3.10	8	2.30				
	2	74	2.20	5	1.70	22	2.20		
	3	74	3.50	11	1.90	22	7.20		
1007ZZ	4	73	12.70	28	13.00				
	5	73	8.60	20	8.30				
	6	73	18.90	25	6.20				
	7	73	9.80	23	5.90				
	8	73	10.00	20	4.90				
	9	73	4.90	17	4.40				
	10	73	7.80	28	4.30				
	11	73	5.20	16	4.90				
	12	73	13.00	4	4.90				
	1	74	8.40	8	6.10				
	2	74	6.00	5	3.90	22	5.80		
	3	74	9.40	11	5.10	22	19.00		

APPENDIX D

PHYSICAL AND CHEMICAL DATA

STORET RETRIEVAL DATE 75/10/16

100701
39 26 05.0 075 41 05.0
NOXONTOWN POND
10 DELAWARE

11EPALES
3

2111202
0006 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P
73/04/10	09 30	0000	13.2		14	120	7.00	21	0.090	1.000	1.300	0.021
	09 30	0004	13.0	10.2		120	7.10	15	0.090	0.900	0.900	0.021
73/07/20	11 40	0000		9.6	32	142	8.50	36	0.050	0.900	0.380	0.009
	11 40	0004		9.0		143	7.40	32	0.060	1.000	0.380	0.013
73/09/29	09 45	0000	21.6	6.0	20	154	7.40	56	0.330	2.000	0.200	0.015
	09 45	0005	21.4			161						

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L
73/04/10	09 30	0000	0.160	32.0
	09 30	0004	0.179	
73/07/20	11 40	0000	0.077	35.2
	11 40	0004	0.132	
73/09/29	09 45	0000	0.120	21.2

STORET RETRIEVAL DATE 75/10/16

100702
39 25 07.0 075 41 18.0
NOXONTOWN POND
10 DELAWARE

11EPALES
3

2111202
0003 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P
73/04/10	10 00	0000	12.2		9	115	7.10	21	0.280	0.900	1.700	0.027
	10 00	0003	12.0	8.8		115	7.10	22	0.300	0.800	1.900	0.022
73/07/20	11 55	0000	27.3	10.5	32	158	8.10	45	0.050	1.000	0.430	0.010
73/09/29	10 00	0000	21.7	4.6	20	154	7.60	51	0.160	2.100	0.240	0.016
	10 00	0004	21.2			161						

24.

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L
73/04/10	10 00	0000	0.266	2.9
	10 00	0003	0.265	
73/07/20	11 55	0000	0.093	76.1
73/09/29	10 00	0000	0.181	58.2

APPENDIX E

TRIBUTARY AND WASTEWATER TREATMENT PLANT DATA

STORET RETRIEVAL DATE 75/10/16

1007A1
39 26 30.0 075 41 00.0
NOXONTOWN POND OUTLET (NO NAME)
10 7.5 MIDDLETOWN
O/NOXONTOWN POND
BRDG XING DAM 3.5 MI SW OF ODESSA
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
73/04/28	09 25		1.220	1.380	0.037	0.013	0.095
73/05/20	13 25		1.050	1.100	0.021	0.017	0.085
73/06/25	13 00		0.231	1.380	0.038	0.021	0.080
73/07/23	09 45		0.252	1.150	0.058	0.016	0.080
73/08/20	09 40			1.200	0.050	0.024	0.110
73/09/16	16 00		0.076	1.470	0.147	0.018	0.125
73/10/28	13 50		0.154	0.950	0.032	0.011	0.095
73/11/16	15 00		0.440	0.700	0.031	0.012	0.115
73/12/04	09 35		0.430	0.900	0.028	0.012	0.120
74/01/08	14 00		1.180	1.100	0.240	0.012	0.095
74/02/05	14 55		1.400	0.800	0.115	0.030	0.085
74/03/11	09 45		1.400	0.900	0.040	0.010	0.080
74/03/22	10 40		1.120	1.000	0.012	0.007	0.080

26.

STORET RETRIEVAL DATE 75/10/16

1007A2
39 24 30.0 075 42 00.0
NOXONTOWN POND INLET (NO NAME)
10 7.5 MIDDLETOWN
I/NOXONTOWN POND
ST HWY 71 BRDG 3 MI S OF MIDDLETOWN
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
73/04/28	09 50		2.500	1.470	0.126	0.023	0.180
73/05/20	13 00		2.400	1.200	0.210	0.024	0.080
73/06/25	12 45		2.100	1.540	0.240	0.067	0.120
73/07/23	09 25		2.400	0.560	0.270	0.014	0.035
73/08/20	10 15			1.000	0.280	0.033	0.095
73/09/17	09 50		1.200	1.260	0.350	0.032	0.100
73/10/28	13 40		1.820	1.050	0.500	0.092	0.140
73/11/16	14 50		2.200	0.500	0.168	0.180	0.290
73/12/04	09 25		2.080	0.500	0.176	0.080	0.155
74/01/08	13 40		2.940	0.600	0.212	0.154	0.250
74/02/05	14 30		3.300	0.500	0.105	0.070	0.110
74/03/11	09 25		2.800	0.700	0.115	0.025	0.070
74/03/22	10 10		2.600	0.600	0.050	0.015	0.080

27.

STORET RETRIEVAL DATE 75/10/16

100781
39 25 00.0 079 40 30.0
UNNAMED STREAM
10 7.5 MIDDLETOWN
T/NOXONTOWN POND
BRDG ON MONEY ROAD
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
73/04/28	09 10		0.510	0.960	0.061	0.036	0.110
73/05/20	13 11		0.895	1.500	0.110	0.018	0.160
73/06/25	12 50		2.100	1.500	0.180	0.023	0.055
73/07/23	09 35		1.300	1.200	0.190	0.014	0.095
73/08/20	10 25			1.100	0.310	0.031	0.200
73/09/17	10 05		0.910	1.690	0.360	0.017	0.045
73/10/28	13 50		0.580	2.800	0.425	0.013	0.400
73/11/16	14 45		0.220	1.830	0.168	0.016	0.575
73/12/04	09 30		0.276	1.600	0.387	0.008	0.300
74/01/08	13 50		1.400	0.500	0.064	0.024	0.055
74/02/05	14 50		2.300	0.300	0.050	0.020	0.045
74/03/11	09 35		1.760	0.650	0.055	0.010	0.025
74/03/22	10 20		0.710	0.800	0.050	0.025	0.135

28.

STORET RETRIEVAL DATE 75/10/16

1007AA AS1007AA P000250
39 25 57.0 075 41 15.0
ST ANDREWS SCHOOL/MIDDLETOWN
10 7.5 MIDDLETON
T/NOXONTOWN POND
APPOQUINIMINK RIVER
11EPALES 2141204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P	50051 FLOW RATE INST MGD	50053 CONDUIT FLOW-MGD MONTHLY
73/07/30	14 00		1.150	2.500	0.350	7.300	7.350	0.002	0.006
73/09/15	11 00		0.740	18.900	5.900	4.220	4.600	0.024	0.013
73/10/17	08 30		1.740	2.700	0.005K	5.000	5.400	0.022	0.019
73/11/19	08 45		0.010K	23.000	8.600	1.470	2.300	0.020	0.020
73/12/17	14 00		0.080		3.400	1.780		0.015	0.018
74/01/18	11 00		0.320	25.000	10.100	3.500	4.300	0.022	0.015
74/02/19	09 00		0.080	19.000	9.500	2.800	3.250	0.029	0.023
74/03/20	11 45		5.300	8.600	0.190	1.750	2.100	0.015	0.019
74/04/26	09 30		0.080	22.000	12.500	3.500	4.050	0.021	0.017
74/05/27	08 35		2.320	5.800	0.170	7.200	7.400	0.013	0.022
74/06/27	09 00		26.000	5.600	0.190	16.500	19.500	0.006	0.011
74/07/29	09 00		56.000	3.200	0.250	13.500	13.500	0.007	0.008
74/08/29	08 45		0.720	9.600	0.050	0.180	9.100	0.008	0.008

29.

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 75/10/16

1007AB AS1007AB P000505
39 24 26.0 075 41 53.0
TOWNSEND S.T.P.
10 7.5 MIDDLETOWN
T/NOXONTOWN POND
UNNAMED STREAM
11EPALES 2141204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P	50051 FLOW RATE INST MGD	50053 CONDUIT FLOW-MGD MONTHLY
73/09/03	11 00	P							
CP(T)- 73/09/03	16 00			24.700		6.000		0.054	0.083
73/10/01	11 00	P							
CP(T)- 73/10/01	16 00		0.260	22.000	12.000	3.900	4.400	0.064	0.064
73/11/01	11 00	P							
CP(T)- 73/11/01	16 00		1.300	13.500	3.800	6.100	6.400	0.065	0.065
73/12/05	09 10		0.340	21.000	9.500	6.100	6.900	0.065	0.065
74/01/02	11 00	P							
CP(T)- 74/01/02	16 00		3.360	3.900	0.160	3.500	3.900	0.065	0.065
74/02/05	10 45	P							
CP(T)- 74/02/05	15 50		6.720	3.700	0.730	3.900	4.300	0.065	0.065
74/03/04	10 00	P							
CP(T)- 74/03/04	15 50		0.160	13.000	4.500	5.100	5.700	0.065	0.065
74/04/03	09 30	P							
CP(T)- 74/04/03	15 25		3.000	2.900	0.510	0.730	0.950	0.065	0.065
74/05/05	11 10	P							
CP(T)- 74/05/05	16 30		0.160	15.000	4.600	1.600	2.200	0.065	0.068
74/06/04	11 15	P							
CP(T)- 74/06/04	15 55		0.240	14.000	3.700	1.850	2.500	0.065	0.065
74/08/05	10 30	P							
CP(T)- 74/08/05	16 15		0.320	9.100	4.100	3.150	3.600	0.065	0.065
74/10/09	11 00	P							
CP(T)- 74/10/09	16 00		7.200	3.300	0.120	3.700	4.200		
74/11/06	11 05	P							
CP(T)- 74/11/06	15 45		0.320	22.000	8.300	6.100	7.800	0.045	0.045

30.